Claims

I claim:

1. A dry supplement injection system connectable to a water supply for supplying water under pressure to produce a slurry from supplements in a micronized form to be used in fertigation application that may contain both dissolved and undissolved supplements which is introduced into a pressurized flow of irrigation water for watering crops, comprising a dry supplement injection device having a main hopper which includes an outer wall defining a main hopper chamber, an upper portion having an inlet opening, and a lower portion having an outlet opening, a perforated funnel assembly disposable within the chamber and which includes an inverted, perforated funnel having a perforated outer wall defining a funnel chamber, a small upper opening, and a large lower opening, a vertically disposed inlet pipe which extends through said upper opening and affixed to said funnel, at least one spray nozzle fluidly connected to said pipe disposed within said funnel chamber to spray water onto said wall of said perforated funnel, an inlet water pipe system which includes a main pipe that connects to the water source through said wall of said main hopper to said inlet pipe and said spray nozzle wherein water discharged from said spray nozzle impinges on said perforated wall of said perforated funnel such that particles of micronized supplement are washed through said perforated funnel forming a slurry, and an outlet water pipe system which includes a slurry pump which draws slurry formed in said main hopper and passed through said outlet opening through a slurry pump inlet pipe and pumps the slurry under pressure through a slurry pump outlet pipe into an irrigation water pipe through which the flow of irrigation water flows for irrigating the crops.

2. The dry supplement injection system according to Claim 1, wherein the main hopper includes a lower funnel-shaped portion having an annular downwardly angled inner surface on which the perforated funnel rests such that the micronized particles in said main hopper are urged by gravity toward and against said perforated funnel, and the slurry formed within said perforated funnel flows downwardly and out of the outlet opening of said main hopper.

3. The dry supplement injection system according to Claim 1, further comprising:

a stand which supports the main hopper with the outlet opening thereof above ground level;

a mixing pan disposed below said stand for receiving and holding slurry from said outlet opening of said main hopper; and

an agitation device operatively connected to said mixing pan which induces movement of the slurry contained within said mixing pan to help prevent settling out of micronized particles in the outlet water pipe system.

4. The dry supplement injection system according to Claim 3, wherein the depth of water within the mixing pan is controlled by a water level regulation device.

5. The dry supplement injection system according to Claim 4, wherein the water level regulation device comprises a float valve disposed along the water inlet piping at the mixing pan.

6. The dry supplement injection system according to Claim 4, further comprising an overflow prevention device which stops the inflow of water through the funnel into the mixing pan when the water level reaches a predetermined maximum water level above that at which the regulation device stops the inflow of water.

7. The dry supplement injection system according to Claim 6, wherein the overflow prevention device comprises an overflow prevention sensor electrically connected to a water solenoid valve disposed along the water inlet piping, said overflow prevention sensor stops the inflow of water through said water inlet pipe into said mixing pan when the depth of the water therein reaches the predetermined maximum water level.

8. The dry supplement injection system according to Claim 3, wherein the mixing pan includes a round bottom wall and an upstanding circular outer wall, and wherein the agitation device comprises a water fill pipe at least an end portion of which extends tangentially to said outer wall within said mixing pan to send the water entering therethrough and within said mixing pan in a circular motion contained by said outer wall.

9. The dry supplement injection system according to Claim 1, wherein there are a plurality of spray nozzles.

10. The dry supplement injection system according to Claim 1, wherein a vertical spray angle of the spray nozzle is between about 130 to 170 degrees.

11. The dry supplement injection system according to Claim 1, wherein the spray nozzle comprises a fixed spray nozzle having no moving parts, and which has a substantially fixed spray pattern against the perforated funnel.

12. The dry supplement injection system according to Claim 1, wherein the spray nozzle comprises a non-fixed spray nozzle having at least one moving part, and which has a moving spray pattern against and along the perforated funnel.

13. The dry supplement injection system according to Claim 12, wherein the non-fixed spray nozzle comprises a rotary spray nozzle which rotates in a continuous three-hundred-sixty-degree spray pattern.

14. The dry supplement injection system according to Claim 12, wherein the non-fixed spray nozzle comprises a butterfly spray nozzle.

15. The dry supplement injection system according to Claim 12, wherein the non-fixed spray nozzle comprises a spinner spray nozzle which sends a water spray in a simultaneous three-hundred-sixty-degree spray pattern.

16. The dry supplement injection system according to Claim 12, wherein the non-fixed spray nozzle comprises a wobbler spray nozzle.

17. The dry supplement injection system according to Claim 1, wherein the perforated funnel includes a resilient annular seal disposed about a lower rim of said perforated funnel to seal against leakage of micronized particles between said perforated funnel and an interior surface of the main hopper.

18. The particulate substance according to Claim 1, wherein dry supplement injection system according to Claim 1, wherein respective perforations of said perforated funnel each comprise a round hole of a diameter of between about one-sixteenth and three-sixteenths inch.

19. The dry supplement injection system according to Claim 1, wherein the perforated funnel has an included angle of between about 20 to 60 degrees.

20. The dry supplement injection system according to Claim 19, wherein the perforated funnel has a height of between about 6 to 12 inches.

21. The dry supplement injection system according to Claim 19, wherein the perforated funnel has a height of between about 12 to 24 inches.

22. The dry supplement injection system according to Claim 19, wherein the perforated funnel has a height of between about 24 to 48 inches.

23. The dry supplement injection system according to Claim 1, wherein the perforated funnel includes a tubular upper portion having at least one longitudinal slot and defining an upper opening of such a diameter to closely receive the water inlet pipe, and a circumferential clamp disposed around said upper portion such that said upper opening is closeable around said water inlet pipe to clamp said perforated funnel to said water inlet pipe.

24. The dry supplement injection system according to Claim 1, wherein a portion of the water inlet pipe disposed within the main hopper comprises respective first and second interior pipes, said first interior pipe being affixed to the wall of the main hopper and said second interior pipe being affixed to the perforated funnel and to which the nozzle is connectable, said first and second interior pipes being hand connectable and disconnectable using a twist coupling for removal of said perforated funnel, second interior pipe, and nozzle from said main hopper.

25. The dry supplement injection system according to Claim 1, wherein a hand operable valve is disposed along the water inlet pipe to permit manual control of the flow of water sent to the perforated funnel.

26. The dry supplement injection system according to Claim 25, wherein a flow meter is disposed along the water inlet pipe to permit monitoring of the flow of water to the perforated funnel.

27. The dry supplement injection system according to Claim 25, wherein an anti-siphon valve is disposed along the water inlet pipe to prevent water from backflowing from the main hopper should water pressure from the water source be lost.

28. The dry supplement injection system according to Claim 1, further comprising a flush water piping system which includes a flush water pipe connected at a first connection point to the water inlet pipe and at a second connection point the slurry outlet pipe between the mixing pan and the pump, said flush water piping system further including respective first and second flush water valves, said first flush water valve being disposed along said flush water pipe to control a flow of flush water therethrough and said second flush water valve being disposed along said slurry outlet pipe between said mixing pan and said second connection point to control the flow of slurry therethrough, said first flush water valve being closed to said flow of flush water and said second flush water valve being open to said flow of slurry during normal operation of the dry supplement injection system, and vice-versa for both priming and flushing of said pump at the beginning and ending of operation of the dry supplement injection system, respectively.

29. The dry supplement injection system according to Claim 28, wherein a three way solenoid valve is disposed along the slurry outlet pipe to which the flush water outlet pipe is connected, said flush water outlet pipe being connectable to a waste water disposal such that said three way solenoid valve may selectively direct slurry and flush water to the irrigation water pipe and to a waste water disposal, respectively.

30. The dry supplement injection system according to Claim 1, wherein an anti-siphon valve is disposed along one of the slurry pump inlet and outlet pipes to prevent water from backflowing therethrough should slurry pressure be lost from the pump.

31. The dry supplement injection system according to Claim 1, wherein a pressure relief pipe is operatively connected to an outlet of the pump to bleed off excess slurry pressure to the flushing water outlet pipe.

32. The dry supplement injection system according to Claim 1, wherein respective electrically actuatable valves are disposed along the main pipe, the water flush pipe, and the slurry pump outlet pipe, said valves being controllable by an electronic controller which is operatively connected to said valves to control the respective flows of water and slurry therethrough and to control a sequence of flows through the dry supplement injection device.

33. The dry supplement injection system according to Claim 32, wherein the pump is powered by an electric motor operatively connected to the controller being controllable thereby.

34. The dry supplement injection system according to Claim 1, wherein the pump comprises a diaphragm pump.

35. The dry supplement injection system according to Claim 34, further comprising a flush water piping system which includes a flush water pipe connected at a first connection point to the

water inlet pipe and at a second connection point the slurry outlet pipe between the mixing pan and said pump, said flush water piping system further including respective first and second flush water valves, said first flush water valve being disposed along said flush water pipe to control a flow of flush water therethrough and said second flush water valve being disposed along said slurry outlet pipe between said mixing pan and said second connection point to control the flow of slurry therethrough, said first flush water valve being closed to said flow of flush water and said second flush water valve being open to said flow of slurry during normal operation of the dry supplement injection system, and vice-versa for both priming and flushing of said pump at the beginning and ending of operation of the dry supplement injection system, respectively.

36. The dry supplement injection system according to Claim 34, wherein a pressure relief pipe is operatively connected to an outlet of the pump to bleed off excess slurry pressure to the flushing water outlet pipe.

37. A dry supplement injection irrigation system connectable to a water supply for supplying water under pressure to produce a slurry from supplements in a micronized form to be used in fertigation application that may contain both dissolved and undissolved supplements, and for introducing the slurry into a flow of irrigation water and spraying onto crops, comprising:

a dry supplement injection device having a main hopper which includes an outer wall defining a main hopper chamber, an upper portion having an inlet opening, and a lower portion having an outlet opening, a perforated funnel assembly disposable within the chamber and which includes an inverted, perforated funnel having a perforated outer wall defining a funnel chamber, a small upper

opening, and a large lower opening, a vertically disposed inlet pipe which extends through said upper opening and affixed to said funnel, at least one spray nozzle fluidly connected to said pipe disposed within said funnel chamber to spray water onto said wall of said perforated funnel, an inlet water pipe system which includes a main pipe that connects to the water source through said wall of said main hopper to said inlet pipe and said spray nozzle wherein water discharged from said spray nozzle impinges on said perforated wall of said perforated funnel such that particles of micronized supplement are washed through said perforated funnel forming a slurry, and an outlet water pipe system which includes a slurry pump which draws slurry formed in said main hopper and passed through said outlet opening through a slurry pump inlet pipe and pumps the slurry under pressure through a slurry pump outlet pipe; and

an irrigation device to which the injection device is connectable having an irrigation water pipe through which the flow irrigation water flows for irrigating the crops.

38. The dry supplement injection irrigation system according to Claim 37, wherein the irrigation device comprises a wheeled irrigation device.

39. The dry supplement injection irrigation system according to Claim 38, wherein the wheeled irrigation device comprises a pivot mounted wheeled irrigation device that slowly pivots about a pivot post affixed to the ground as respective wheels thereof are driven.

40. The dry supplement injection irrigation system according to Claim 39, wherein the pivot mounted wheeled irrigation device includes a plurality of wheels which are rotatably connected

in pairs to respective A-frames spaced along a horizontally disposed elevated irrigation water supply pipe that is vertically supported therebetween by respective brace wire assemblies, with a plurality of respective spray heads extending downwardly from said irrigation water supply pipe between said A-frames for discharging water downwardly and outwardly onto the crops being irrigated, said wheels being rotationally powerable on said A-frames by respective water motors which are attached to said A-frames and powered by the pressurized irrigation water such that said pivot mounted wheeled irrigation device slowly pivots about the pivot post as said wheels are driven.

41. A continuous feed dry supplement injection system connectable to a water supply for supplying water under pressure to produce a slurry from supplements in a micronized form to be used in fertigation application that may contain both dissolved and undissolved supplements which is introduced into a flow of irrigation water for watering crops, comprising:

a dry supplement injection device having a main hopper which includes an outer wall defining a main hopper chamber, an upper portion having an inlet opening, and a lower portion having an outlet opening, a perforated funnel assembly disposable within the chamber and which includes an inverted, perforated funnel having a perforated outer wall defining a funnel chamber, a small upper opening, and a large lower opening, a vertically disposed inlet pipe which extends through said upper opening and affixed to said funnel, at least one spray nozzle fluidly connected to said pipe disposed within said funnel chamber to spray water onto said wall of said perforated funnel, an inlet water pipe system which includes a main pipe that connects to the water source through said wall of said main hopper to said inlet pipe and said spray nozzle wherein water discharged from said spray nozzle impinges on said perforated wall of said perforated funnel such that particles of micronized

supplement are washed through said perforated funnel forming a slurry, and an outlet water pipe system which includes a slurry pump which draws slurry formed in said main hopper and passed through said outlet opening through a slurry pump inlet pipe and pumps the slurry under pressure through a slurry pump outlet pipe into an irrigation water pipe through which the flow of irrigation water flows for irrigating the crops;

a motorized feed screw assembly which includes a feed screw hopper for receiving the micronized supplement, and a motorized feed screw which includes an inclined outer tube having an inlet connected to a lower outlet of said feed screw hopper and which is upwardly inclined from said feed screw hopper to an outlet disposed above said inlet opening of said main hopper, a feed screw which closely fits within said outer tube and being rotationally driven by a motor; and

wherein the micronized supplement enters said outer tube through said inlet thereof and is transported through through said outer tube by said feed screw to said outlet and into said main hopper for production of slurry therefrom.

42. The continuous feed dry supplement injection system according to Claim 41, further comprising a bulk bag unloading system operably connected to the hoppered feed screw for receiving and unloading bulk bags of the micronized supplement into the feed screw hopper of the hoppered feed screw.

43. The continuous feed dry supplement injection system according to Claim 42, wherein the bulk bag unloading system includes an overhead loading system which includes an upright main frame having an upper portion to which is affixed an I-beam which carries a rollable motorized lift

device having a dependent lift member adapted for attachment to the bulk bags for lifting, lowering, and horizontal movement of the bulk bags from a loading position to an unloading position over the feed screw hopper of the hoppered feed screw for emptying of the micronized supplement into the feed screw hopper of the hoppered feed screw and back.

44. The continuous feed dry supplement injection system according to Claim 42, wherein the bulk bag unloading system includes an upright main frame having an upper portion which is removable from a lower portion thereof, said upper portion being adapted lifting using a fork lift and for hanging the bulk bags for loading and unloading thereof and of a sufficient height so as to support the bulk bags off of a supporting floor surface when separated from said lower portion such that lifting, lowering, and horizontal movement of the bulk bags from a loading position to an unloading position over the feed screw hopper of the hoppered feed screw for emptying of the micronized supplement into the feed screw hopper of the hoppered feed screw and back.

45. The continuous feed dry supplement injection system according to Claim 44, wherein the bulk bag unloading system includes a shaker which is operatively connectable to the bulk bags to facilitate transfer of the micronized supplement from the bulk bag to the feed screw hopper of the hoppered feed screw.

46. A micronized particulate composition for use in supplement injection systems, comprising a plurality of particles of at least one material, wherein at least between about ninety-five to ninety-nine percent of said particles are smaller than about 74 microns (200 mesh) in size.

47. The micronized particulate composition according to Claim 46, wherein at least between about ninety to ninety-five percent of the particles are smaller than about 74 microns (200 mesh) in size.

48. The micronized particulate composition according to Claim 46, wherein at least between about seventy-five to ninety percent of the particles are smaller than about 74 microns (200 mesh) in size.

49. The micronized particulate composition according to Claim 46, wherein at least between about fifty to seventy-five percent of the particles are smaller than about 74 microns (200 mesh) in size.

50. The micronized particulate composition according to Claim 46, wherein at least one material of the composition is at least partially soluble in water.

51. The micronized particulate composition according to Claim 50, wherein all of the materials of the composition is at least partially soluble in water.

52. The micronized particulate composition according to Claim 46, wherein at least one material of the composition is chosen from the set of chemicals consisting of sulfate of potash, gypsum, potassium nitrate, potassium magnesium sulfate, mono-ammonium phosphate, diammonium phosphate, ammonium sulfate, and potassium chloride.

53. The micronized particulate composition according to Claim 46, wherein the composition is packaged in bulk bags for use with a bulk bag unloading system.

54. The micronized particulate composition according to Claim 46, wherein at least one material of the composition is useful as a supplement for crops.

55. A method of introducing a dry supplement into a flow of irrigation water, comprising the steps of:

providing a dry micronized supplement;

producing a slurry of the micronized supplement and water, which slurry may contain both dissolved and undissolved particles of the micronized supplement, by spraying water at an interior surface of an inverted perforated funnel which separates the dry micronized supplement from an interior chamber of the funnel; and

pumping the slurry produced into a flow of irrigation water for watering crops.

56. The method according to Claim 55, wherein the step of producing the slurry is conducted by spraying water which is at a pressure of at least about 45 pounds per square inch (3 bars) guage pressure.

57. The method according to Claim 55, wherein the step of providing the dry micronized supplement comprises providing dry micronized supplement that includes at least some gypsum, and wherein the steps of producing the slurry and pumping the slurry produced into the flow of irrigation

water are conducted using water flow rates to produce the slurry and of the irrigation water such that an amount of gypsum used in the process exceeds the saturation point of the gypsum in water of about one pounds of gypsum per every fifty gallons of water.

58. The method according to Claim 55, wherein the step of producing the slurry is conducted using a perforated funnel which includes a resilient annular seal disposed about a lower rim of the perforated funnel to seal against leakage of micronized particles between the perforated funnel and an interior surface of the main hopper.

59. The method according to Claim 55, wherein the step of producing the slurry is conducted using a perforated funnel wherein respective perforations thereof each comprise a round hole of a diameter smaller than about one-eighth inch.

60. The method according to Claim 55, wherein the step of producing the slurry is conducted using a perforated funnel which has an included angle of between about 20 to 60 degrees.

61. The method according to Claim 60, wherein the step of producing the slurry is conducted using a perforated funnel which has a height of between about 6 to 12 inches.

62. The method according to Claim 60, wherein the step of producing the slurry is conducted using a perforated funnel which has a height of between about 12 to 24 inches.

63. The method according to Claim 60, wherein the step of producing the slurry is conducted using a perforated funnel which has a height of between about 24 to 48 inches.

64. The method according to Claim 55, wherein the step of producing the slurry is conducted using a spray nozzle having a vertical spray angle of between about 130 to 170 degrees.

65. The method according to Claim 55, wherein the steps of providing a dry micronized supplement comprises providing a dry micronized supplement wherein at least between about ninety-five to ninety-nine percent of the particles are smaller than about 74 microns (200 mesh) in size.

66. The method according to Claim 55, wherein the step providing a dry micronized supplement comprises providing a dry micronized supplement wherein at least between about ninety to ninety-five percent of the particles are smaller than about 74 microns (200 mesh) in size.

67. The method according to Claim 55, wherein the step providing a dry micronized supplement comprises providing a dry micronized supplement wherein at least between about seventy-five to ninety percent of the particles are smaller than about 74 microns (200 mesh) in size.

68. The method according to Claim 55, wherein the step of pumping the slurry produced is conducted using a type of irrigation chosen from the group consisting of sprinkler irrigation, pivot irrigation, flood irrigation, drip irrigation, hand line irrigation, and wheel line irrigation.

69. The method according to Claim 55, wherein the step of pumping the slurry produced is conducted using a diaphragm pump.

70. The method according to Claim 55, wherein the step of producing the slurry is conducted using a mixing pan which receives and collects the slurry produced prior to pumping the slurry.

71. The method according to Claim 70, wherein the step of producing the slurry includes agitating the slurry collected in the mixing pan to minimize settling out of undissolved particles therein.

72. The method according to Claim 70, wherein the step of producing the slurry includes regulating the slurry within the mixing pan between a minimum and a maximum depth by adding additional water to the slurry collected in the mixing pan.

73. The method according to Claim 72, wherein the step of producing the slurry includes regulating and adding water to the slurry using a float valve, wherein entry of the additional water into the mixing pan agitates the slurry collected in the mixing pan to minimize settling out of undissolved particles therein.

74. The method according to Claim 55, wherein the step of producing the slurry is conducted using a plurality of spray nozzles disposed within the interior chamber of the perforated funnel.

75. A dry supplement injection system connectable to a water supply for supplying water under pressure to produce a slurry from supplements in a micronized form to be used in fertigation application that may contain both dissolved and undissolved supplements which is introduced into a non-pressurized flow of irrigation water for watering crops, comprising:

a dry supplement injection device having a main hopper which includes an outer wall defining a main hopper chamber, an upper portion having an inlet opening, and a lower portion having an outlet opening;

a perforated funnel assembly disposable within the chamber and which includes an inverted, perforated funnel having a perforated outer wall defining a funnel chamber, a small upper opening, and a large lower opening, a vertically disposed inlet pipe which extends through said upper opening and affixed to said funnel, at least one spray nozzle fluidly connected to said pipe disposed within said funnel chamber to spray water onto said wall of said perforated funnel;

an inlet water pipe system which includes a main pipe that connects to the water source through said wall of said main hopper to said inlet pipe and said spray nozzle wherein water discharged from said spray nozzle impinges on said perforated wall of said perforated funnel such that particles of micronized supplement are washed through said perforated funnel forming a slurry; and

an outlet water pipe system which includes a slurry pump outlet pipe through which slurry formed in said main hopper and passed through said outlet opening flows by gravity feed into

a non-pressurized irrigation water conduit through which the flow of irrigation water flows for irrigating the crops.

76. The dry supplement injection system according to Claim 75, wherein the main hopper includes a lower funnel-shaped portion having an annular downwardly angled inner surface on which the perforated funnel rests such that the micronized particles in said main hopper are urged by gravity toward and against said perforated funnel, and the slurry formed within said perforated funnel flows downwardly and out of the outlet opening of said main hopper.

77. The dry supplement injection system according to Claim 75, further comprising:

a stand which supports the main hopper with the outlet opening thereof above ground level;

a mixing pan disposed below said stand for receiving and holding slurry from said outlet opening of said main hopper; and

an agitation device operatively connected to said mixing pan which induces movement of the slurry contained within said mixing pan to help prevent settling out of micronized particles in the outlet water pipe system.

78. The dry supplement injection system according to Claim 77, wherein the depth of water within the mixing pan is controlled by a water level regulation device.

79. The dry supplement injection system according to Claim 78, wherein the water level regulation device comprises a float valve disposed along the water inlet piping at the mixing pan.

80. The dry supplement injection system according to Claim 78, further comprising an overflow prevention device which stops the inflow of water through the funnel into the mixing pan when the water level reaches a predetermined maximum water level above that at which the regulation device stops the inflow of water.

81. The dry supplement injection system according to Claim 80, wherein the overflow prevention device comprises an overflow prevention sensor electrically connected to a water solenoid valve disposed along the water inlet piping, said overflow prevention sensor stops the inflow of water through said water inlet pipe into said mixing pan when the depth of the water therein reaches the predetermined maximum water level.

82. The dry supplement injection system according to Claim 77, wherein the mixing pan includes a round bottom wall and an upstanding circular outer wall, and wherein the agitation device comprises a water fill pipe at least an end portion of which extends tangentially to said outer wall within said mixing pan to send the water entering therethrough and within said mixing pan in a circular motion contained by said outer wall.

83. The dry supplement injection system according to Claim 75, wherein there are a plurality of spray nozzles.

84. The dry supplement injection system according to Claim 75, wherein a vertical spray angle of the spray nozzle is between about 130 to 170 degrees.